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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 4 : D06H 3/08, G01N 33/36, 21/89

A1

(11) International Publication Number: WO 89/04887

(43) International Publication Date: 1 June 1989 (01.06.89)

(21) International Application Number: PCT/NL88/00051

(22) International Filing Date: 22 November 1988 (22.11.88)

(31) Priority Application Number: 8702805

(32) Priority Date: 23 November 1987 (23.11.87)

(33) Priority Country: NL

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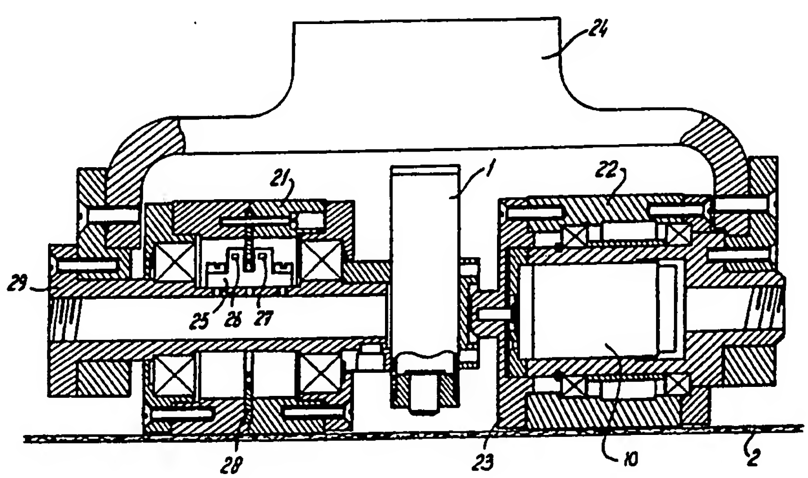
(81) Designated States: AT (European patent), BE (European patent), CH (European patent), DE (European patent), FR (European patent), GB (European patent), IT (European patent), JP, LU (European patent), NL (European patent), SE (European patent), US.

Published
With international search report.

(54) Title: DEVICE FOR THE OPTICAL DETERMINATION OF PERIODICITIES IN TEXTILE BANDS OR WEBS



(57) Abstract

Device for the optical determination of periodicities in textile bands, such as woven or knitted cloth, is provided with a light source for directing light radiation towards a band of cloth, a light detector for detecting light radiation reflected by the fabric and converting it into an electrical signal with varying intensity, and a signal processing circuit for determining periodicities related to the cloth and present in the electrical signal. Said signal processing circuit is constructed for counting threads or stitches and is provided with a high-frequency filter followed by a low-frequency filter for removing noise and low-frequency interference respectively from the said electrical signal and with an amplitude threshold stage with adjustable thresholds for assessing subsequent amplitudes. A measuring means is provided in said light source and light detector are combined into a single sensor (1) which is mounted next to one or two rollers (21, 22) mounted on a common spindle attached to a bracket (24), the roller(s) being pressed against the band of cloth (2). A tachometer (10) is coupled to one side of the common spindle to deliver a speed signal proportionate to the instantaneous roller speed, and an optical cell (25) is provided in one roller (21) to deliver a length pulse signal proportionate to the roller circumference.

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Device for the optical determination of periodicities in textile bands or webs.

The invention relates to a device for the optical determination of periodicities in textile bands, such as woven or knitted cloth, provided with a light source for directing light radiation towards a band of cloth under examination, a light detector for detecting light radiation reflected by the fabric and converting the latter - in accordance with the intensity of the reflected light radiation - into an electrical signal with varying intensity, and a signal processing circuit for detecting periodicities related to the cloth and present in the electrical signal. Such a device is known in practice.

The signals, which in general correspond to the radiation originating from the various points of cloth, are mixed with considerable noise, inter alia as a consequence of the very irregular scattering or reflection by the cloth threads or stitches and are consequently unsuitable for directly determining the periodicities which are associated with the nature of the cloth. The device according to the invention is capable of deriving periodicities, which are characteristic of the various webs of cloths encountered, from said signals. To detect the periodicities which are characteristic of a particular cloth, the electrical signals are preferably converted into digital form in order to simplify the processing.

It is furthermore important that, in the manufacture of textile webs, such as woven or knitted cloth, for example knitwear, an ever increasing number of arrangements are made to keep the stresses in the cloth as low as possible and to prevent shrinkage. In this manufacturing process, dryers are an important component because the stresses in the cloth are more or less fixed by the drying. By contracting the cloth, depending on the number of threads or stitches per unit of length, at the entrance to the dryer, a small and constant shrinkage can be obtained over the entire length of the band of cloth. To control these modern cloth dryers, it is therefore necessary to measure the number of threads

(of woven fabric) or stiches (of knitted fabric) per unit of length. As a consequence of the design of the dryer, this measurement has to be done at the exit from the dryer.

The object of the invention is to comply with this and to provide a device, of the type mentioned in the introduction, which is suitable for counting threads or stitches. The device according to the invention is, for this purpose, characterized in that the signal processing circuit is constructed for counting threads or stitches in an advancing band or web of cloth and is provided with a high-frequency filter followed by a low-frequency filter for removing noise and low-frequency interference respectively from the said electrical signal, and with an amplitude threshold stage with adjustable thresholds for assessing the amplitude of the electrical signal, a thread or stitch in the cloth being reproduced in the electrical signal by an amplitude peak which is characterized by a maximum and two adjacent minima and the amplitude differences existing between said maximum and the two minima.

The invention will be explained in more detail on the basis of some exemplary embodiments with reference to the drawings, in which:

Figure 1 shows an embodiment of a sensor used in the device according to the invention;

Figure 2 shows an example of a band or web of cloth, such as a knitted fabric, the stitches of which have to be counted;

Figure 3 shows an embodiment of the measuring means to be used in the device according to the invention;

Figure 4 shows a block diagram of the signal processing section of the device according to the invention;

Figures 5a and 5b show examples, respectively of the electrical signal derived from the measuring means and obtained after filtering high frequencies and rescaling, and the electrical signal obtained after filtering the low frequencies; and

Figure 6 shows an example of a peak occurring in the electrical signal with associated amplitude differences with respect to adjacent minima.

Figure 1 shows diagrammatically in cross-section an embodiment of a signal sensor 1 for the device according to the inven-

tion. The sensor 1 is at the same time intended for measurements on moving cloth 2.

The sensor 1 according to Figure 1 comprises a radiation source 3, for example a light emitting diode, having a lens 4 for focussing the radiation emitted by the source 3 at a point 5 on the cloth 2, and also a lens for imaging the radiation spot 5 on a radiation detector 7, for example a photodiode. Said detector is connected to an output conductor 8. If the band of cloth 2 moves, the radiation arriving at the point 2 will be reflected at the passing point of the cloth 2, in various ways so that an electrical signal can be delivered to the conductor 8, the intensity of which varies in accordance with the variations in radiation.

Obviously, other detectors which are able to operate in a corresponding manner can also be used.

Figure 2 gives an example of a piece of band of cloth which comprises in this case a knitted fabric, such as flat knitwear. Such a band of cloth is manufactured, for example, on a circular knitting machine and then has a flattened tubular form which is passed in the stress-free state through the dryer as a web of two layers of knitwear. Because of the tubular form, only the right-hand side of the knitted fabric can be observed as in Figure 1 since this side is directed outwards both at the bottom and at the top.

The manner in which the loops of the knitted fabric are formed follows from Figure 2, right-hand part of the diagram. In the vertical direction, two regions can be distinguished, namely region A which indicates the vertical strips situated at the surface of the knitted fabric which are formed by the right-hand edge of the loops which form a continuous, virtually straight line. The more deeply situated region B shows the left-hand edge of the loops which are situated somewhat more deeply in the knitted fabric and also run more obliquely. From Figure 2 it is evident that region B is the most suitable for counting the number of loops or stitches. In the region A, the stitches are in line with each other and the measurement of said stitches is therefore more difficult.

A so-called optical reflective sensor (ORS) as shown in Figure 1 is again preferably chosen for counting, in general, the

threads in woven fabric or the stitches in knitted fabric. This cell is able to sense the cloth optically in the direction of advance. The electrical signal is dependent on the reflective properties of the cloth (for example, colour) and the distance between the cloth and the sensor. The signal delivered by the sensor is analog and can be sampled with the aid of an analog/-digital (A/D) converter and a microcomputer in short time intervals so that a digital signal suitable for further processing is obtained. At the same time, the sampling frequency must be matched to the speed of the advancing web of cloth in order to obtain a signal from which the number of threads or stitches can be determined.

Figure 3 shows the measuring means associated with the device and incorporating the said sensor.

Since the distance between cloth and sensor is very critical, said sensor 1 is preferably mounted between two rollers 21, 22 mounted on a common spindle attached to a bracket 24. Said measuring means is pressed against the cloth 2 which is advanced over a drum which is not shown, as a result of which the sensor moves at the same time at a fixed distance from the cloth, with possible movements perpendicular to the spindle of the drum. It is also possible to work with one roller mounted on the spindle and to place the sensor laterally alongside it.

Figure 3 further shows how the spindle incorporates a speed gauge or tachometer 10 in the right-hand roller 22 which is used to measure the speed continuously. The spindle of the rotating part of the tachometer 10 is coupled in a fixed manner at the left-hand side to the face end 23 of the rotating roller 22. The electrical connection wires (not shown) of the tachometer are fed out to the right-hand side.

The left-hand roller 21 incorporates an optical cell 25 which is coupled in a fixed manner to the fixed spindle 29. The optical cell which is composed of a light-delivering emitter 26 and a light detector 27 interacts with a disc 28 which is coupled in a fixed manner to the roller 21 and in which one or more through holes are provided at the same radial distance from the spindle as the light emitter and detector. The combination of optical cell 25 and disc 28 functions as a length gauge which delivers a pulse signal every

time the circumference of the roller has traversed, for example one revolution and consequently a length of 10 cm. The electrical connecting wires, which are not shown, of optical cell 25 and sensor 1, run via the fixed spindle 29 to the bracket.

In said measuring means, the sensor, speed gauge and length gauge are combined in an extraordinarily practical manner with the roller(s) incorporated in the bracket.

In a first method of measurement, the tachometer 10 is used. This method of measurement is based on the number of sensings during a period of time in which a certain length of band of cloth passes. The distance which is traversed during said period is calculated a few milliseconds before each measurement fron the speed measured with the tachometer. In this connection, it is essential that the speed remains constant before and during the measurement since otherwise the time is not a measure of the quantity of cloth which passes during the measurement. During the fixed measuring time the cloth is sensed with the aid of the sensor. By deriving the number of periodicities from the electrical signal delivered by the sensor and relating them to the measured length, the number of threads or stitches per unit of length can be determined.

In the second method of measurement, use is made of the length gauge 25, 28 which each time delivers a pulse signal for each interval of length, for example every 10 cm, 20 cm, or 40 cm (adjustable). By measuring the cloth with the sensor between two pulse signals, a fixed length of the band of cloth is examined independently of the speed. The processing of the signal is then identical to the measurement with the aid of the tachometer.

Figure 4 shows a block diagram of a processing circuit for the device according to the invention. Thr output conductor 8 of the sensor 1 is connected to an analog/digital converter 9 which converts the analog output signals of the sensor 1 into digital signals.

In the case of the sensor 1 of Figure 1, which is only capable of operating with a moving band 2, the speed of the band 2 is measured with the aid of a tachometer or speed gauge 10. The speed measurement signals are transmitted via a conductor 11 to the

converter 9 in order to sample the analog signals from the sensor 1 as a function of the band speed in order to form a digital series which then becomes independent of the speed of the band 2. The length measurement signals from the optical cell 25 are fed to the converter 9 via the conductor 12.

The series of digital signals is first fed via a hig-frequency filter 13 which filters out the noise and then via a low-frequency filter 14 which filters out the low-frequency interference. The signal is then fed via an amplitude threshold stage 15 having several adjustable thresholds, after which it is processed further or displayed in the display/recording stage 16.

Figure 5a shows the signal derived from the sensor with the high frequencies (noise) filtered out. Low-frequency interference is then removed from the signal, as shown in the Figure 5b. In the ideal case, each peak in this signal would correspond to a thread or stitch in the cloth, which peak is then characterized by a maximum and two minima adjacent thereto.

Hereinafter, stitches (in knitted fabric) are also understood to mean threads (in woven fabric).

Figure 6 gives an example of such a peak in which the amplitude differences between the maximum and the adjacent minima are shown, respectively, Δy_1 and Δy_2 and the distances between the minima and the maximum, respectively, by Δx_1 and Δx_2.

The said amplitude differences, i.e. Δy, vary a fair amount from peak to peak, as follows from Figure 5b. In the region A of Figure 2, the amplitude differences will be smaller than in the region B. In determining the number of stitches, it is first necessary to consider which peaks can be evaluated as stitches. That is to say, the respective amplitude differences must be included in the consideration. In this connection, all the peaks may be considered as stitches regardless of their height, or only those peaks with an amplitude above a certain minimum and below a certain maximum, the number of stitches per centimeter being determined with the aid of the associated Δx's. In the first case, too high a number of stitches is generally obtained since peaks are included in the calculation which are not the result of stitches. In the second case, a better determination is obtained as a result of the

fact that we are certain which peaks correspond to stitches. That will generally apply to those peaks which are not too small (which may be noise) and which occur often (assuming that we are mainly observing stitches).

The amplitude differences (Δy) of the processed signal shown in Figure 5b have been grouped into eight classes over the whole range of, for example, 256 steps. How many amplitude differences fall within such a class is given by the following table:

Class	Range	Number
1	0- 32	8
2	32- 64	14
3	64- 96	33
4	96-128	42
5	128-160	55
6	160-192	35
7	192-224	21
8	224-256	4

It emerges that the measurement is suitable as a rough means of control in processing the advancing cloth. It is advisable to base the final result on several measurements over lengths of cloth which are not too short.

A problem may be the temperature of the cloth on leaving the dryer since the measuring means assumes the temperature of the cloth in a short time. Said temperature of the cloth must not be too high, at any rate not higher than 40°C. As a further control, a temperature detector can be incorporated in the measuring means so that a warning can be given if the temperature is too high. The measuring means may also be provided with a cooling system.

It is obvious that the invention is not restricted to the embodiment shown but that changes and modifications may be made within the scope of the invention. Thus, the measuring means may be protected against destructive factors such as water and dirt, on the one hand, by a better screening of the system and, on the other hand, by a more robust construction of the measuring means itself. Thus, the lens system of the sensor may be kept free of dust particules, for example, with compressed air. It could also act as cooling.

The device described above may advantageously be used in order to achieve, in the processing of the cloth, an automatic adjustment of said processing to the quality of the cloth examined optically. This may be done, for example, with the aid of an intelligent program which optimizes the evaluation parameters for each new cloth. In this manner, in determining the number of threads or stitches per unit of length at the exit from the dryer, it is possible to establish the manner in which the inlet has to be adjusted.

CLAIMS

1. Device for the optical determination of periodicities in textile bands, such as woven or knitted cloth, provided with a light source for directing light radiation towards a band of cloth under examination, a light detector for detecting light radiation reflected by the fabric and converting the latter - in accordance with the intensity of the reflected light radiation - into an electrical signal with varying intensity, and a signal processing circuit for determining periodicities related to the cloth and present in the electrical signal, characterized in that the signal processing circuit is constructed for counting threads or stitches in an advancing band of cloth and is provided with a high-frequency filter followed by a low-frequency filter for removing noise and low-frequency interference respectively from the said electrical signal and with an amplitude threshold stage with adjustable thresholds for assessing the amplitude of the electrical signal, a thread or stitch in the cloth being reproduced in the electrical signal by an amplitude peak which is characterized by a maximum and two adjacent minima and the amplitude differences between said maximum and the two minima.

2. Device according to Claim 1, characterized in that the amplitude threshold stage circuit is constructed to evaluate the peaks as threads or stitches, the said amplitude differences of which are situated above a certain lower limit and below a certain upper limit.

3. Device according to Claim 1, characterized in that light source and light detector are combined to form a single sensor which is mounted next to one or two rollers mounted on a common spindle attached to a bracket, the roller(s) being pressed against the band of cloth which advances over a drum.

4. Device according to Claim 3, characterized in that a tachometer is coupled to one side of the common spindle in order to deliver a speed signal, which is proportional to the instantaneous

speed of the rollers, continuously to the signal processing circuit.

5. Device according to Claim 3, characterized in that, in one of the rollers, an optical cell is provided which consists of light emitter and light detector placed opposide each other, which cell is coupled in a fixed manner to the spindle and interacts with a disc which is provided in the roller and rotates along with it and between light emitter and light detector and which is provided with a through hole, aligned with the optical cell, which generates, after certain length intervals have been traversed which are linked to the circumference of the roller, a pulse signal which is delivered to the signal processing circuit.

fig-1

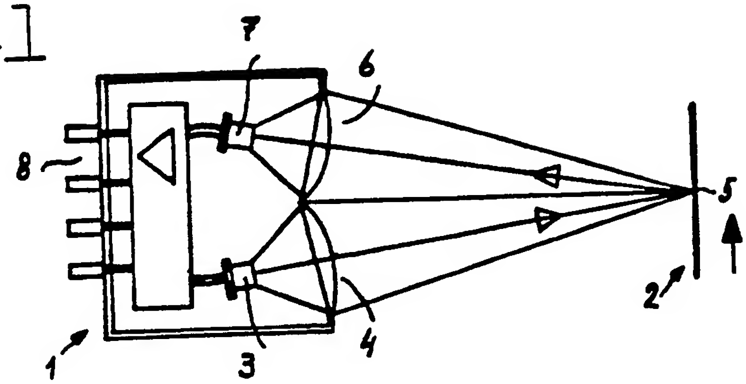
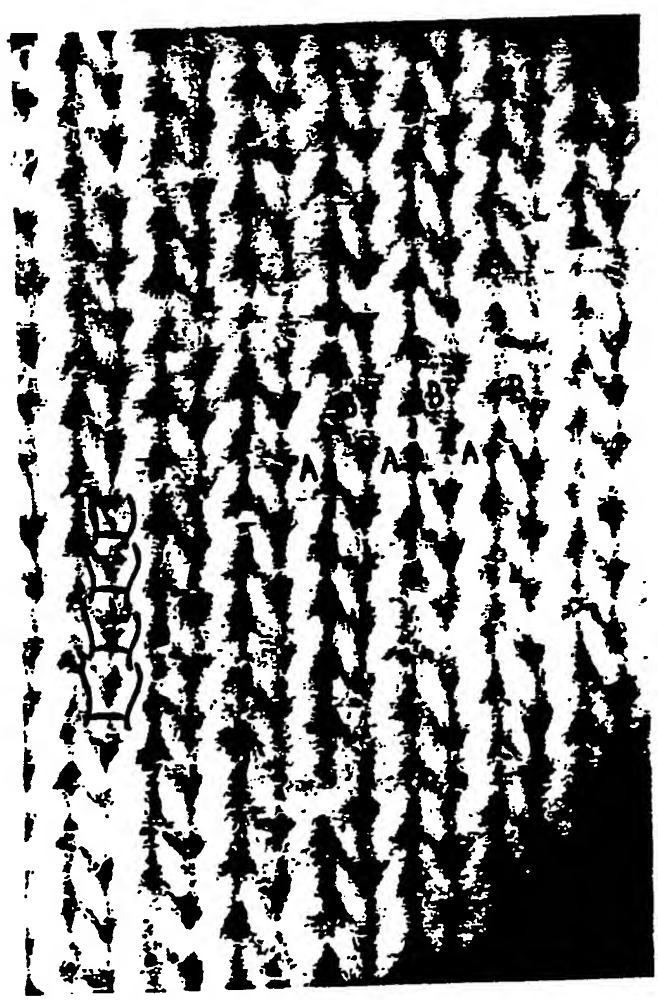


fig-2



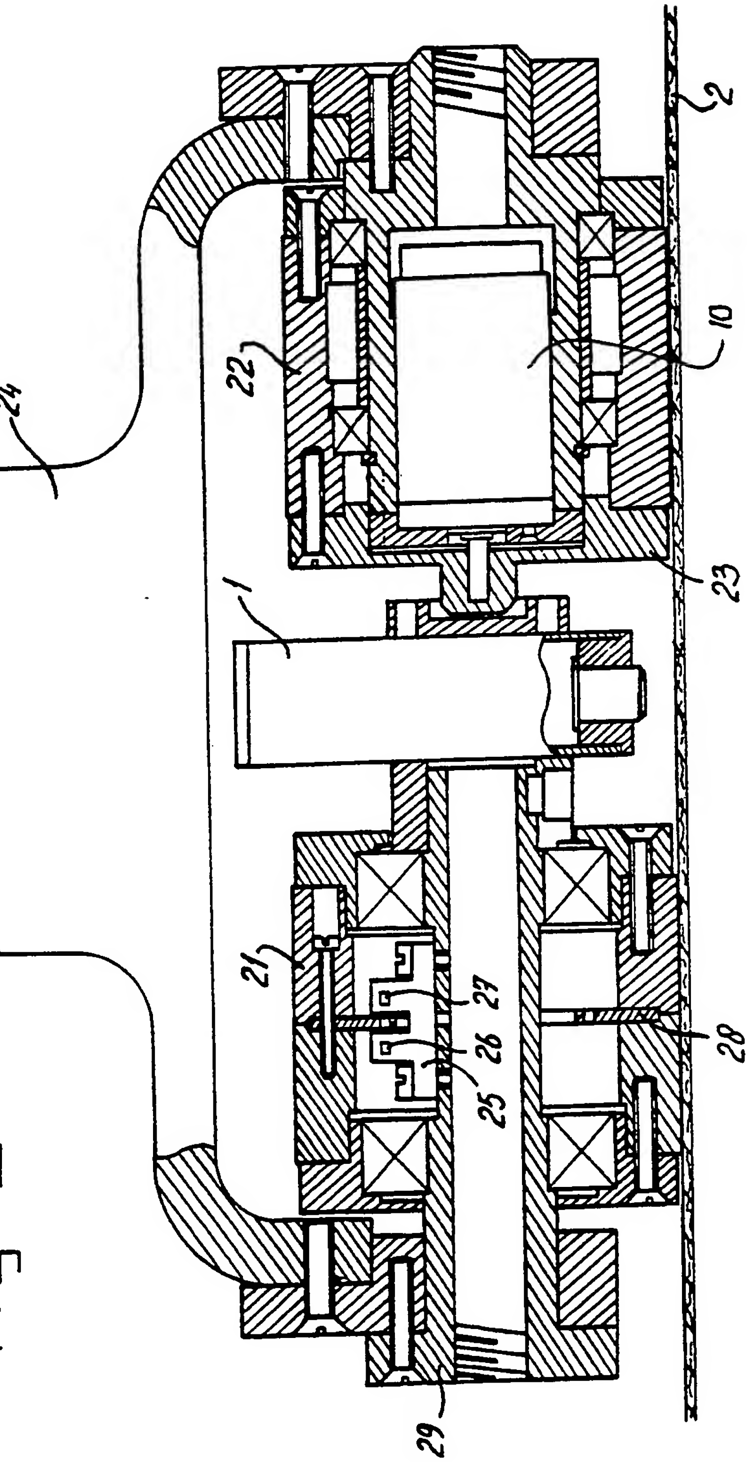


Fig-3

fig-4

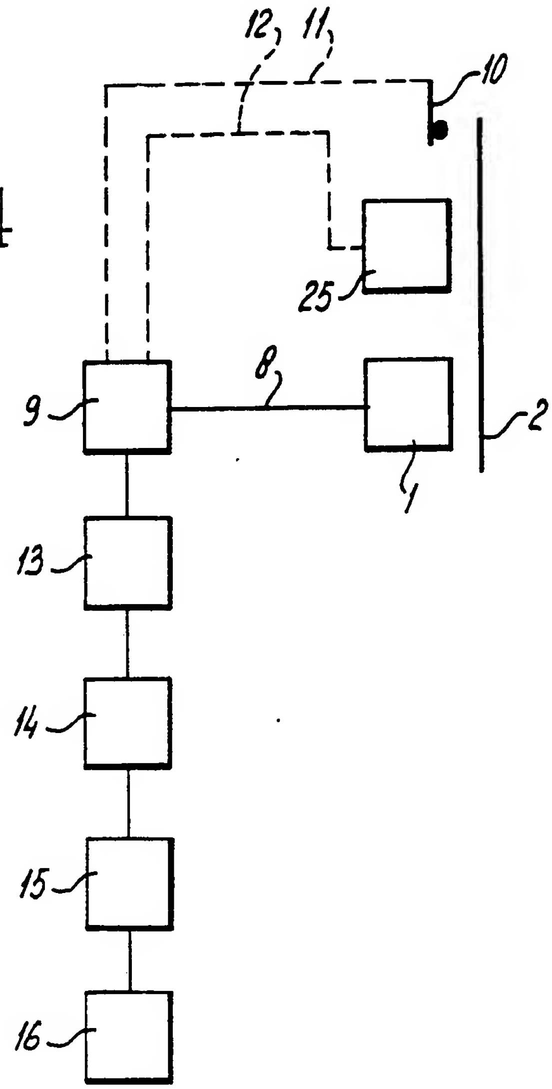


fig-5a

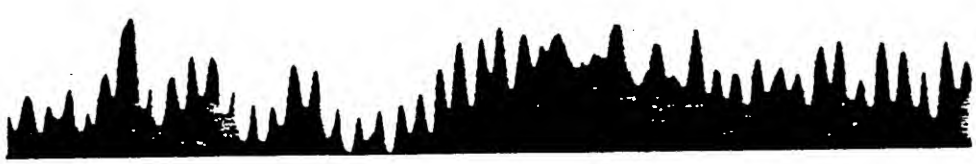
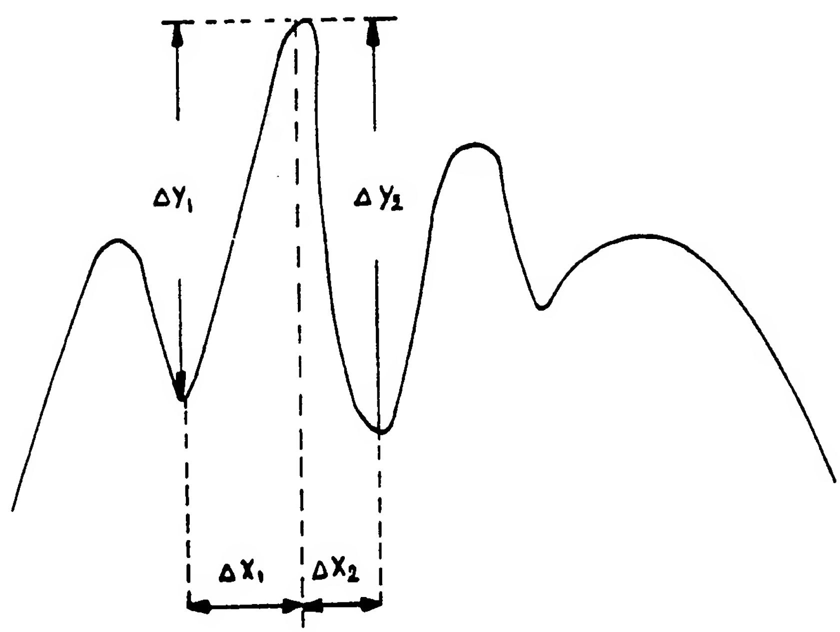


fig-5b

Fig-6



INTERNATIONAL SEARCH REPORT

International Application No PCT/NL 88/00051

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC^4: D 06 H 3/08; G 01 N 33/36; G 01 N 21/89

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC^4	D 06 H; G 01 N; G 01 B

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category [*]	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
X	EP, A, 0160895 (R. MASSEN) 13 November 1985 see page 2, lines 31-35; pages 3-5; page 9, lines 17-34; page 11, lines 10-33; page 12, lines 1-31; page 22, lines 11-34; page 23, lines 1-18; pages 25-26 --	1,2
A	US, A, 3469104 (N.F. HECTOR) 23 September 1969 see the whole document --	1
A	US, A, 4490618 (P.G. CIELO) 25 December 1984 see column 4, lines 48-66 --	3
A	De Tex, volume 29, no. 12, December 1970, H.C. Puper: "Rendement van breisels (II)", pages 926-930 see the whole document --	1
A	US, A, 2966593 (A. LEIMER) ./.	1

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
14th February 1989	15. 03. 89
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	P.C.G. VAN DER PUTTEN

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
	27 December 1960 see column 3, lines 15-75; column 4, lines 1-30 --	
P,X	EP, A, 0277694 (CENTEXBEL) 10 August 1988 see columns 4-7 --	1,2
A	CH, A, 366685 (H. KRANTZ SÖHNE) 28 February 1963 --	
A	GB, A, 2068113 (E.C. LEAR et al.) 5 August 1981 --------	

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. NL 8800051 SA 25456

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.
The members are as contained in the European Patent Office EDP file on 07/03/89
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP-A- 0160895	13-11-85	DE-A- 3416883	14-11-85
		JP-A- 61019864	28-01-86
		US-A- 4586372	06-05-86
US-A- 3469104	23-09-69	NL-A- 6600413	25-08-66
		DE-A- 1573726	14-01-71
		GB-A- 1079618	
		CH-A- 431135	
		FR-A- 1463720	
US-A- 4490618	25-12-84	CA-A- 1192417	27-08-85
US-A- 2966593		None	
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CH-A- 366685		None	
GB-A- 2068113	05-08-81	DE-A- 3100235	07-01-82

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